

WHAT IS CLAIMED IS:

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1. A method of embedding digital watermark information
b₁ - b_n (2 ≤ n) in image data, comprising steps of:
dividing the image data into a plurality of areas S
each consisting of M × N (1 ≤ M, N) pixels;
defining a plurality of areas G each consisting of P
× Q (1 ≤ P, Q) of the areas S;
allocating each of the areas S constituting each
area G to some one of: areas T₁ - T_n in which said digital
watermark information b₁ - b_n is respectively embedded and
areas H₁ - H_m (1 ≤ m) in which information is not embedded;
locating one or more areas T and one or more areas H
in a predetermined arrangement in each area G; and
locating the plurality of areas G in a predetermined
rule.

2. A method of embedding digital watermark information
b₁ - b_n (2 ≤ n) in image data, comprising steps of:
dividing the image data into a plurality of areas S
each consisting of M × N (1 ≤ M, N) pixels;
defining a plurality of areas G each consisting of P
× Q (1 ≤ P, Q) of the areas S;
allocating each of the areas S constituting each
area G to some one of: areas T₁ - T_n in which said digital
watermark information b₁ - b_n is respectively embedded,

10 areas $J_1 - J_k$ ($1 \leq k$) in which information $p_1 - p_k$ ($1 \leq k$)
11 specifying an embedding format for embedding said digital
12 watermark information $b_1 - b_n$ in said areas $T_1 - T_n$, and
13 areas $H_1 - H_m$ ($1 \leq m$) in which information is not embedded;
14 locating one or more areas T , one or more areas J ,
15 one or more areas H in a predetermined arrangement in each
16 area G ; and
17 locating the plurality of areas G in a predetermined
18 rule.

1 3. The method of embedding digital watermark
2 information according to Claim 2, wherein:

3 said digital watermark information $b_1 - b_n$ is
4 embedded by increasing or decreasing pixel data values in
5 the corresponding areas $T_1 - T_n$ according to a bit value (0,
6 1) of each bit of the digital watermark information $b_1 - b_n$;
7 and

8 said information $p_1 - p_k$ specifying said embedding
9 format is embedded such that said information indicates a
10 pattern of respective increasing/decreasing directions in
11 the area $T_1 - T_n$ for a bit value of the digital watermark
12 information, in each area G to which the areas $J_1 - J_k$
13 embedded with said information $p_1 - p_k$ belong.

1 4. The method of embedding digital watermark
2 information according to Claim 1, wherein:

3 each of said areas G includes a plurality of said
4 areas H that have been allocated so as to be asymmetric in
5 vertical and horizontal directions in the area G in
6 question.

1 5. A method of extracting digital watermark
2 information, for extracting the digital watermark
3 information $b_1 - b_n$ ($2 \leq n$) from image data in which said
4 digital watermark information is embedded, comprising steps
5 of:

6 dividing the image data into a plurality of areas S
7 each consisting of $M \times N$ ($1 \leq M, N$) pixels;

8 detecting areas $H_1 - H_m$ ($1 \leq m$) in which information
9 is not embedded, from said plurality of areas S; and

10 recognizing a plurality of areas G each consisting
11 of $P \times Q$ ($1 \leq P, Q$) of the areas S, said plurality of areas
12 G being located on said image data, and said recognition
13 being carried out based on locations of said detected areas
14 $H_1 - H_m$ ($1 \leq m$) on said image data.

1 6. A method of extracting digital watermark
2 information, for extracting the digital watermark
3 information $b_1 - b_n$ ($2 \leq n$) from image data in which said
4 digital watermark information is embedded, comprising steps
5 of:

6 dividing the image data into a plurality of areas S

7 each consisting of $M \times N$ ($1 \leq M, N$) pixels;
8 detecting areas $H_1 - H_m$ ($1 \leq m$) in which information
9 is not embedded, from said plurality of areas S ;
10 recognizing a plurality of areas G each consisting
11 of $P \times Q$ ($1 \leq P, Q$) of the areas S , said plurality of areas
12 G being located on said image data, and said recognition
13 being carried out based on locations of said detected areas
14 $H_1 - H_m$ ($1 \leq m$) on said image data;
15 in each of the plurality of areas G recognized,
16 extracting information $p_1 - p_k$ ($1 \leq k$) from areas $J_1 - J_k$ in
17 which said information $p_1 - p_k$ ($1 \leq k$) should be embedded,
18 said information $p_1 - p_k$ specifying an embedding format for
19 embedding said digital watermark information $b_1 - b_n$
20 respectively in said areas $T_1 - T_n$;
21 recognizing the embedding format of the digital
22 watermark information $b_1 - b_n$ in the areas $T_1 - T_n$ in the
23 area G in question; and
24 extracting the digital watermark information $b_1 - b_n$
25 from the areas $T_1 - T_n$, according to the recognized
26 embedding format.

1 7. The method of extracting digital watermark
2 information according to Claim 6, wherein:
3 for each of the plurality of groups G recognized,
4 the information $p_1 - p_k$ embedded in the areas $J_1 - J_k$ is
5 extracted to recognize a pattern of increasing/decreasing

6 directions of pixel data values for a bit value of the
7 digital watermark information, in the area G in question;
8 and
9 each bit value of the digital watermark information
10 $b_1 - b_n$ embedded in the areas $T_1 - T_n$ is detected according
11 to the recognized pattern of increasing/decreasing
12 directions.

1 8. The method of extracting digital watermark
2 information according to Claim 5, wherein:
3 a plurality of areas H are detected from each of the
4 areas G;
5 the detected areas H are compared with an embedding
6 pattern for the areas H, said embedding pattern being
7 determined in advance such that the areas H become
8 asymmetric in vertical and horizontal directions in the
9 area G in question; and
10 contents of image processing carried out on the
11 image data are judged.

1 9. A program product for making a computer execute a
2 method of embedding digital watermark information $b_1 - b_n$ (2
3 $\leq n$) in image data, comprising:
4 codes for dividing the image data into a plurality
5 of areas S each consisting of $M \times N$ ($1 \leq M, N$) pixels;
6 codes for defining a plurality of areas G each

7 consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S ;
8 codes for allocating each of the area S constituting
9 each area G to some one of: areas $T_1 - T_n$ in which said
10 digital watermark information $b_1 - b_n$ is respectively
11 embedded and areas $H_1 - H_m$ ($1 \leq m$) in which information is
12 not embedded;
13 codes for locating one or more areas T and one or
14 more areas H in a predetermined arrangement in each area G ;
15 codes for locating the plurality of areas G in a
16 predetermined rule; and
17 a computer readable storage medium for holding the
18 codes.

1 10. A program product for making a computer execute a
2 method of embedding digital watermark information $b_1 - b_n$ (2
3 $\leq n$) in image data, comprising:
4 codes for dividing the image data into a plurality
5 of areas S each consisting of $M \times N$ ($1 \leq M, N$) pixels;
6 codes for defining a plurality of areas G each
7 consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S ;
8 codes for allocating each of the areas S
9 constituting each area G to some one of: areas $T_1 - T_n$ in
10 which said digital watermark information $b_1 - b_n$ is
11 respectively embedded, areas $J_1 - J_k$ ($1 \leq k$) in which
12 information $p_1 - p_k$ ($1 \leq k$) specifying an embedding format
13 for embedding said digital watermark information $b_1 - b_n$ in

14 said areas $T_1 - T_n$, and areas $H_1 - H_m$ ($1 \leq m$) in which
15 information is not embedded;
16 codes for locating one or more areas T , one or more
17 areas J , and one or more areas H in a predetermined
18 arrangement in each area G ;
19 codes for locating the plurality of areas G in a
20 predetermined rule; and
21 a computer readable storage medium for holding the
22 codes.

1 11. The program product according to Claim 10, further
2 comprising:

3 codes for embedding said digital watermark
4 information $b_1 - b_n$ by increasing or decreasing pixel data
5 values in the corresponding areas $T_1 - T_n$ according to a bit
6 value (0, 1) of each bit of the digital watermark
7 information $b_1 - b_n$; and

8 codes for embedding said information $p_1 - p_k$
9 specifying said embedding format such that said information
10 indicates a pattern of respective increasing/decreasing
11 directions in the areas $T_1 - T_n$ for a bit value of the
12 digital watermark information, in each area G to which the
13 areas $J_1 - J_k$ embedded with said information $p_1 - p_k$ belong.

1 12. The program product according to Claim 9, wherein:
2 each of said areas G includes a plurality of said

3 areas H that have been allocated so as to be asymmetric in
4 vertical and horizontal directions in the area G in
5 question.

1 13. A program product for making a computer execute a
2 method of extracting digital watermark information $b_1 - b_n$
3 ($2 \leq n$) from image data in which said digital watermark
4 information is embedded, comprising:

5 codes for dividing the image data into a plurality
6 of areas S each consisting of $M \times N$ ($1 \leq M, N$) pixels;

7 codes for detecting areas $H_1 - H_m$ ($1 \leq m$) in which
8 information is not embedded, from said plurality of areas
9 S;

10 codes for recognizing a plurality of areas G each
11 consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S, said
12 plurality of areas G being located on said image data, and
13 said recognition being carried out based on locations of
14 said detected areas $H_1 - H_m$ ($1 \leq m$) on said image data; and
15 a computer readable storage medium for holding the
16 codes.

1 14. A program product for making a computer execute a
2 method of extracting digital watermark information $b_1 - b_n$
3 ($2 \leq n$) from image data in which said digital watermark
4 information is embedded, comprising:

5 codes for dividing the image data into a plurality

6 of areas S each consisting of $M \times N$ ($1 \leq M, N$) pixels;
7 codes for detecting areas $H_1 - H_m$ ($1 \leq m$) in which
8 information is not embedded, from said plurality of areas
9 S;
10 codes for recognizing a plurality of areas G each
11 consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S, said
12 plurality of areas G being located on said image data, and
13 said recognition being carried out based on locations of
14 said detected areas $H_1 - H_m$ ($1 \leq m$) on said image data;
15 codes for extracting, in each of the plurality of
16 areas G recognized, information $p_1 - p_k$ ($1 \leq k$) from areas
17 $J_1 - J_k$ in which said information $p_1 - p_k$ ($1 \leq k$) should be
18 embedded, said information $p_1 - p_k$ specifying an embedding
19 format for embedding said digital watermark information b_1
20 $- b_n$ respectively in said areas $T_1 - T_n$;
21 codes for recognizing the embedding format of the
22 digital watermark information $b_1 - b_n$ in the areas $T_1 - T_n$
23 in the area G in question;
24 codes for extracting the digital watermark
25 information $b_1 - b_n$ from the areas $T_1 - T_n$, according to the
26 recognized embedding format; and
27 a computer readable storage medium for holding the
28 codes.

1 15. The program product according to Claim 14, further
2 comprising:

3 codes for extracting, for each of the plurality of
4 groups G recognized, the information $p_1 - p_k$ embedded in the
5 areas $J_1 - J_k$, to recognize a pattern of
6 increasing/decreasing directions of pixel data values for a
7 bit value of the digital watermark information, in the area
8 G in question, and to detect each bit value of the digital
9 watermark information $b_1 - b_n$ embedded in the areas $T_1 - T_n$
10 according to the recognized pattern of
11 increasing/decreasing directions.

1 16. The program product according to Claim 13, further
2 comprising:

3 codes for detecting a plurality of areas H from each
4 of the areas G:

5 codes for comparing the detected areas H with an
6 embedding pattern for the areas H, said embedding pattern
7 being determined in advance such that the areas H become
8 asymmetric in vertical and horizontal directions in the
9 area G in question; and.

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10         codes for judging contents of image processing
11 carried out on the image data.

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1 17. An apparatus for embedding digital watermark
2 information $b_1 - b_n$ ($2 \leq n$) in image data, comprising:

3 a processing part for dividing the image data into a
4 plurality of areas S each consisting of $M \times N$ ($1 \leq M, N$)

5 pixels;
6 a processing part for defining a plurality of areas
7 G each consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S;
8 a processing part for allocating each of the areas S
9 constituting each area G to some one of: areas $T_1 - T_n$ in
10 which said digital watermark information $b_1 - b_n$ is
11 respectively embedded and areas $H_1 - H_m$ ($1 \leq m$) in which
12 information is not embedded;
13 a processing part for locating one or more areas T
14 and one or more areas H in a predetermined arrangement in
15 each area G; and
16 a processing part for locating the plurality of
17 areas G in a predetermined rule.

1 18. An apparatus for embedding digital watermark
2 information $b_1 - b_n$ ($2 \leq n$) in image data, comprising:
3 a processing part for dividing the image data into a
4 plurality of areas S each consisting of $M \times N$ ($1 \leq M, N$)
5 pixels;
6 a processing part for defining a plurality of areas
7 G each consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S;
8 a processing part for allocating each of the areas S
9 constituting each area G to some one of: areas $T_1 - T_n$ in
10 which said digital watermark information $b_1 - b_n$ is
11 respectively embedded, areas $J_1 - J_k$ ($1 \leq k$) in which
12 information $p_1 - p_k$ ($1 \leq k$) specifying an embedding format

13 for embedding said digital watermark information $b_1 - b_n$ in
14 said areas $T_1 - T_n$, and areas $H_1 - H_m$ ($1 \leq m$) in which
15 information is not embedded;

16 a processing part for locating one or more areas T ,
17 one or more areas J , and one or more areas H in a
18 predetermined arrangement in each area G ; and

19 a processing part for locating the plurality of
20 areas G in a predetermined rule.

1 19. The apparatus for embedding digital watermark
2 information according to Claim 18, further comprising:

3 a processing part for embedding said digital
4 watermark information $b_1 - b_n$ by increasing or decreasing
5 pixel data values in the corresponding areas $T_1 - T_n$
6 according to a bit value (0, 1) of each bit of the digital
7 watermark information $b_1 - b_n$; and

8 a processing part for embedding said information p_1
9 - p_k specifying said embedding format such that said
10 information indicates a pattern of respective
11 increasing/decreasing directions in the area $T_1 - T_n$ for a
12 bit value of the digital watermark information, in each
13 area G to which the areas $J_1 - J_k$ embedded with said
14 information $p_1 - p_k$ belong.

1 20. The apparatus for embedding digital watermark
2 information according to Claim 17, wherein:

3 each of said areas G includes a plurality of said
4 areas H that have been allocated so as to be asymmetric in
5 vertical and horizontal directions in the area G in
6 question.

1 21. An apparatus for extracting digital watermark
2 information $b_1 - b_n$ ($2 \leq n$) from image data in which said
3 digital watermark information is embedded, comprising:

4 a processing part for dividing the image data into a
5 plurality of areas S each consisting of $M \times N$ ($1 \leq M, N$)
6 pixels;

7 a processing part for detecting areas $H_1 - H_m$ ($1 \leq$
8 m) in which information is not embedded, from said
9 plurality of areas S; and

10 a processing part for recognizing a plurality of
11 areas G each consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S,
12 said plurality of areas G being located on said image data,
13 and said recognition being carried out based on locations
14 of said detected areas $H_1 - H_m$ ($1 \leq m$) on said image data.

1 22. An apparatus for extracting digital watermark
2 information $b_1 - b_n$ ($2 \leq n$) from image data in which said
3 digital watermark information is embedded, comprising:

4 a processing part dividing the image data into a
5 plurality of areas S each consisting of $M \times N$ ($1 \leq M, N$)
6 pixels;

7 a processing part for detecting areas $H_1 - H_m$ ($1 \leq$
8 m) in which information is not embedded, from said
9 plurality of areas S ;

10 a processing part for recognizing a plurality of
11 areas G each consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S ,
12 said plurality of areas G being located on said image data,
13 and said recognition being carried out based on locations
14 of said detected areas $H_1 - H_m$ ($1 \leq m$) on said image data;

15 a processing part for extracting, in each of the
16 plurality of areas G recognized, information $p_1 - p_k$ ($1 \leq k$)
17 from areas $J_1 - J_k$ in which said information $p_1 - p_k$ ($1 \leq k$)
18 should be embedded, said information $p_1 - p_k$ specifying an
19 embedding format for embedding said digital watermark
20 information $b_1 - b_n$ respectively in said areas $T_1 - T_n$;

21 a processing part for recognizing the embedding
22 format of the digital watermark information $b_1 - b_n$ in the
23 areas $T_1 - T_n$ in the area G in question; and

24 a processing part for extracting the digital
25 watermark information $b_1 - b_n$ from the areas $T_1 - T_n$,
26 according to the recognized embedding format.

1 23. The apparatus for extracting digital watermark
2 information according to Claim 22, further comprising:

3 a processing part for extracting, for each of the
4 plurality of groups G recognized, the information $p_1 - p_k$
5 embedded in the areas $J_1 - J_k$, to recognize a pattern of

6 increasing/decreasing directions of pixel data values for a
7 bit value of the digital watermark information, in the area
8 G in question, and to detect each bit value of the digital
9 watermark information $b_1 - b_n$ embedded in the areas $T_1 - T_n$
10 according to the recognized pattern of
11 increasing/decreasing directions.

1 24. The apparatus for extracting digital watermark
2 information according to Claim 21, further comprising:
3 a processing part for detecting a plurality of areas
4 H from each of the areas G; and
5 a processing part for comparing the detected areas H
6 with an embedding pattern for the areas H, said embedding
7 pattern being determined in advance such that the areas H
8 become asymmetric in vertical and horizontal directions in
9 the area G in question; and
10 a processing part for judging contents of image
11 processing carried out on the image data.

1 25. An apparatus for embedding digital watermark
2 information $b_1 - b_n$ ($2 \leq n$) in image data, comprising:
3 a processor; and
4 a storage unit for storing codes for making the
5 processor execute a method of embedding the digital
6 watermark information; wherein:
7 said codes comprises:

8 codes for dividing the image data into a plurality
9 of areas S each consisting of $M \times N$ ($1 \leq M, N$) pixels;
10 codes for defining a plurality of areas G each
11 consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S;
12 codes for allocating each of the areas S
13 constituting each area G to some one of: areas $T_1 - T_n$ in
14 which said digital watermark information $b_1 - b_n$ is
15 respectively embedded, areas $J_1 - J_k$ ($1 \leq k$) in which
16 information $p_1 - p_k$ ($1 \leq k$) specifying a embedding format
17 for embedding said digital watermark information $b_1 - b_n$ in
18 said areas $T_1 - T_n$, and areas $H_1 - H_m$ ($1 \leq m$) in which
19 information is not embedded;
20 codes for locating one or more areas T, one or more
21 areas J, and one or more areas H in a predetermined
22 arrangement in each area G; and
23 codes for locating the plurality of areas G in a
24 predetermined rule.

1 26. An apparatus for extracting digital watermark
2 information $b_1 - b_n$ ($2 \leq n$) from image data in which said
3 digital watermark information is embedded, comprising:
4 a processor; and
5 a storage unit for storing codes for making the
6 processor execute a method of extracting the digital
7 watermark information; wherein:
8 said codes comprises:

9 codes for dividing the image data into a plurality
10 of areas S each consisting of $M \times N$ ($1 \leq M, N$) pixels;
11 codes for detecting areas $H_1 - H_m$ ($1 \leq m$) in which
12 information is not embedded, from said plurality of areas
13 S;
14 codes for recognizing a plurality of areas G each
15 consisting of $P \times Q$ ($1 \leq P, Q$) of the areas S, said
16 plurality of areas G being located on said image data, and
17 said recognition being carried out based on locations of
18 said detected areas $H_1 - H_m$ ($1 \leq m$) on said image data; and
19 codes for extracting, in each of the plurality of
20 areas G recognized, information $p_1 - p_k$ ($1 \leq k$) from areas
21 $J_1 - J_k$ in which said information $p_1 - p_k$ ($1 \leq k$) should be
22 embedded, said information $p_1 - p_k$ specifying an embedding
23 format for embedding said digital watermark information b_1
24 - b_n respectively in said areas $T_1 - T_n$.
25